Coast - Morphology - Response to a submerged breakwater

Case: Morphological response to submerged breakwater

Modelling steps

Intro

The morphological response to submerged breakwaters case continues on the hydrodynamic case described under Hydrodynamics. This case will illustrate the capabilities of Delft3D in simulating morphological response to submerged breakwaters.

Approach

To include morphological processes the Delft3D-MOR model is selected. In this schematized case only one sediment class is taken into account. Similar to the hydrodynamic case constant offshore boundary conditions are used. This results in a static bed level equilibrium profile, whereas under varying offshore boundary conditions a dynamic equilibrium bed profile would form.

For more details see model set-up.

Model setup

Using Delft3D-MOR several additional parameters have to be taken into account:

- Spatial varying sediment layer: To include a non erosive submerged breakwater, a spatial varying sediment layer thickness can be applied. Use for instance Quickin to construct the .sdb file.
- Morfac: To speed up morphological processes, a morphological acceleration factor is used. This factor is limited to the magnitude of bed level changes. Although indicative relations are developed, maximum values for accuracy reasons are still based on trial and error approach.
- Equilibrium sand concentration profile at inflow boundaries. Select this option to maintain the initial bathymetry along your boundaries
- Minimum depth for sediment calculation. This value sets the minimum depth for the sediment calculations as spurious results may occur for shallow depths.

Results

Conclusions from results:

- Morphological response to submerged breakwaters corresponds well to the initial erosive 2’ accretive 4 cell current pattern.
- For accretive cases, a salient develops in the lee of the submerged breakwater. Near the breakwater heads erosion is visible as a result of the return current. Along the shoreline sediment is transferred to the lee of the submerged breakwater, also resulting in erosion.
- For erosive cases, sediment is transported from the lee of the submerged breakwater to offshore.
- For both cases the morphological changes result in a new equilibrium profile. As a result of the morphological changes alongshore differences in water level decrease.
- Delft3D is capable of clearly distinguish between erosive and accretive submerged breakwaters.
- Although no thorough calibration/validation is included, Delft3D results are in good agreement with field observations of for instance the PEP Reef, Florida USA and the Gold Coast Narrowneck surfing reef, Australia.
Sensitivity analysis shows that morphological response to submerged breakwater is sensitive to a variety of design sbw and environmental parameters. In the figure below results of the equilibrium -0.5m depth contour are presented for a varying offshore distance.

Other important design parameters are, amongst others:

- Offshore distance sbw
- Length sbw
- Crest level
- Crest width
- Wave height, direction and directional spreading
- Sediment characteristics
- Breakwater roughness

Publications